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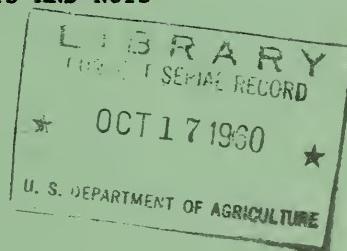
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SERIES I. EVALUATION OF FOREIGN FRUITS AND NUTS

NO. 10. WALNUTS



EVALUATION OF PERSIAN WALNUT INTRODUCTIONS

by

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Agricultural Research Service  
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Evaluation of Persian Walnut Introductions  
U. S. Plant Introduction Station  
Chico, California

R. L. Smith<sup>1</sup>, L. E. Joley<sup>1</sup>, and W. E. Whitehouse<sup>2</sup>

## INTRODUCTION

This report summarizes evaluation data on a collection of Walnuts (Juglans regia L.) growing at the U. S. Plant Introduction Station, Chico, California, with special reference to climatic variations. This collection, averaging 20 years of age or older, consists of 149 seedlings representing 67 introductions from 12 countries, plus varieties Manregian (P.I. 18256), Sorrentina (P.I. 33189), and Wheeler Franquette. For comparison purposes, nuts of the varieties Eureka, Franquette, Hartley, and Payne have been included.

## PROCEDURE

The data compiled for this paper were taken during 1943 to 1946 with additional information added in 1958 and 1959. Factors evaluated were dates of first terminal leafing and full bloom, dichogamy, yield, harvest season, average diameter and shape of nut, separation, percentage, average weight and color of kernels, and eating quality. The first terminal leafing dates were determined when approximately 5 percent of the terminal leaves over the entire tree had grown to approximately one-fourth inch. Dates of full male bloom were determined when about 75 percent of the catkins were shedding pollen and full female bloom when about 75 percent of the pistillate flowers were expanded.

The countries of source (Table 1) are listed alphabetically and under each the seedlings are arranged from earliest to latest average date of first terminal leafing for 1948 and 1949. Dates of first terminal leafing are used since it is felt that they are a more reliable index of the end of the dormant period than are blossoming dates.

Under dichogamy (Table 1) the flowering of individuals is considered protandrous (Pa) when pollen shedding occurs before the pistillate flowers are receptive and protogynous (Pg) when the pistillate flowers are receptive before pollen shedding.

The harvest season of each introduction was designated, early (E) for those ripening with Payne, generally the last week of September; mid-season (M) for individuals ripening with Hartley and Eureka, usually Mid-October, or late (L) for those maturing with Franquette, often the last week of October.

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Any which ripened later than November 1 were designated very late (VL).

The nut and kernel characteristics were averages of 10 or more nuts in most instances and represent a particular year when the information could be obtained.

The average diameter was based on measurements taken at the widest cross-sectional area of the nut.

The shapes of these walnuts, with but few exceptions, were compared either with Payne (P) which is nearly round, Franquette (F) which is slightly oblong or Eureka (E) which is oblong.

Separation refers to the ease with which the kernel cracks out of the shell. This ranges from poor (P) where broken pieces of kernel remain tightly wedged in the shell; through fair (F), where whole kernels or large pieces can be cracked out but often with some difficulty, to good (G), where whole kernels can be cracked out with comparative ease.

Percentage of kernel expresses the weight of the kernel in relation to the weight of the whole nut, while the kernel weight is an indication of its relative size.

The color classification for kernels was based on the U.S.D.A. Agricultural Marketing Service, Walnut Control Board Color Chart (11). They were classified by this chart as either extra light, light, light amber or amber when over 50 percent of the kernels of any selection would fall into one of the color classifications.

Table 2 was arranged to indicate the relationship between source and date of first terminal leafing for each seedling in 1948 and 1949.

The weather data presented in Table 3 was compiled from official weather bureau records taken at a weather station located approximately 1/2 mile from the walnut introductions. This table shows the average temperatures with departure from normal, total precipitation with departure from normal and cumulative summations of hours of temperature below 45°F. in monthly periods from September to April 30 for 1947-48 and 1948-49.

#### PHENOLOGY

In the spring of 1948 there was a spread of 55 days from the time the earliest seedling showed first terminal leaves to the latest (Table 2), whereas in 1949 all of the seedlings started growth within a 23 day period.

As indicated in Table 3, October, November, and December of 1947 had below normal average monthly temperatures followed by a warm January which averaged 48.8°F. or 2.9°F. above normal. This was the warmest January in 34 years with 7 days during the month that had maximum temperatures of 65°F. or over. February turned cool again with an average temperature of 46.8°F. or 2.3°F. below the February normal. The dormant season for



1948-49 was unusually cold. Both November and December had below average temperatures and January 1949 was one of the coldest months on record for Chico, averaging 37.5°F., a deficiency of 8.4°F. February and March were also below normal by 3.5 and 2.9°F. respectively.

#### EVALUATION

In the following summary the walnut introductions are discussed by country of source listing both the average characteristics within each group along with observations pertaining to selections of special interest.

#### Afghanistan

The trend, although variable, was toward earliness of leafing and blossoming among the introductions from Afghanistan with generally early to mid-season harvest. General size, appearance and quality of the nuts was good, comparing favorably with commercial varieties grown in the Chico area. The average crackout percentage and kernel size would also meet commercial standards. Although kernel color tends to be dark, with the majority classified light amber, the following four seedlings produced light colored kernels: P.I. 127460 at orchard location D 42-13<sup>1</sup>, P.I. 159562, P.I. 159566, and P.I. 163539. Of special interest among the light kerneled selections is P.I. 159562, for its lateness of bloom, good quality of kernel, kernel separation, and cropping record. The parent tree of P.I. 163539 is reported to have grown at 7000 ft. where minimum temperatures of -30°F. have been recorded. It produces paper shell nuts of good flavor (10). Others of interest are P.I. 159558, a protogynous selection with an early harvest season producing large nuts of good kernel size and quality, and P.I. 159568 that also matures early and has good nut and kernel size. This latter selection has also shown evidence of blight resistance at Davis, California (7).

Although the introductions from Afghanistan are known to come from areas with considerable cold, seedlings of 5 selections from this source have failed to survive at Morden, Canada (9). Clones of 5 accessions were killed at Hermiston, Oregon, by a November freeze (4) and at Norris, Tennessee, the trial of 3 clones proved they were too susceptible to spring frosts (14). Seedlings of 23 selections grown at Cheyenne, Wyoming, since 1950 were killed to the ground by a December 1959 freeze of -24°F. (3). One seedling at Salem, Ohio, shows some promise of being cold hardy (8).

1/ The orchard location is given to identify the seedling described where there is more than one seedling of an introduction under evaluation.



Algeria

There was only a single representative from Algeria. It is about mid-season in bloom and produces nuts of good size, although many of the kernels darken and shrivel under Chico conditions.

Bulgaria

The introductions from Bulgaria tend to bloom in mid-season and produce nuts with small dark kernels of only fair quality.

Chile

The one introduction from this source P.I. 265716 may be of interest for its apparent low chilling requirements and early maturing nuts of good kernel size and quality.

China

The four introductions from China tend to leaf out and bloom early. One from this source, P.I. 125248, is of interest for its good cropping record, large size nuts of good quality, and kernels which are mostly light colored. A seedling selection P.I. 18256, of particular merit from this source, has been named Manregian and has demonstrated cold hardiness in Oregon. Its seedlings have also been reported to withstand -20°F. in the New England states (6). The indications in Michigan, however, are that Manregian and some of its seedlings are less hardy than Carpathian types (5).

In a search for better walnut rootstocks conducted by Oregon State College, Manregian rated the highest of all the English walnuts tested for germination, seedling height, caliper, and uniformity of growth (15).

Estonia

Trees from this source tended to leaf out and bloom later than the average accession. As a group the Estonian walnuts averaged the smallest size of those tested at Chico. The typical kernel was small and light amber in color. Selection P.I. 265719 is of interest for its light colored kernels and very good separation.

Although walnuts from Estonia should possess cold hardiness seedlings of 7 introductions failed to survive at Morden, Canada. Two clonal selections



were killed by a November freeze at Hermiston, Oregon, and at Norris, Tennessee, 2 clones proved too susceptible to late spring frosts. However, seedling progeny of two selections show some cold hardiness at Salem, Ohio (8).

#### India

Introductions from India were mid-season or earlier in showing first terminal leaves and bloom. Size of nuts and kernels from this source was good but in general some difficulty was experienced in extracting the kernels from the shell. Selection P.I. 265718 is noted for its very small irregularly shaped nut much resembling the nuts produced by the paradox hybrid walnut J. regia x J. hindsii.

#### Iran

Iranian introductions tended to leaf out and bloom early under Chico conditions. Nuts from this group tended to be large and yielded light amber kernels of good quality. Of particular interest is P.I. 125243 D38-3, for its large nuts, better than average kernel separation, and light colored meats.

#### Italy

The variety Sorrentina, P.I. 33189, a single introduction from Italy, yielded good crops of fair sized Eureka shaped nuts, having light amber colored kernels of good quality.

A tree of the Sorrentina variety budded to the Chinese wingnut Pterocarya stenoptera (13) planted in 1940 measures 7 feet 2 inches in circumference one foot above the bud union and is about 40 feet in height. Another tree of this variety propagated on J. hindsii, and planted in the same orchard in 1934, measures 9 feet in circumference one foot above the bud union and is about 50 feet in height. The tree on J. hindsii shows moderate overgrowth of the root, whereas the tree on P. stenoptera is still showing no overgrowth of either scion or stock.

#### Manchuria

The one introduction from Manchuria is early leafing and blooming, and has large size nuts with large light amber kernels of good quality.



Poland

The Polish introductions, from areas other than the Carpathian Mountains were the latest to show terminal leafing in the spring of any of the populations tested at Chico. Most of the nuts from this source were small. Some of the better selections are: P.I. 142327 with light colored kernels of good size and quality; P.I. 142331 with unusually large square shaped late maturing nuts somewhat like the Wilson Wonder type; P.I. 159548 with good nut quality and early maturity and P.I. 228149 with early maturity.

Seedlings representing 15 Polish selections have been killed by low temperatures at Morden, Canada, and frozen to the ground at Cheyenne, Wyoming. Some of the progeny of 5 of these same accessions are showing cold resistance at Salem, Ohio (8).

Walnuts from the Carpathian Mountains on the other hand are quite variable as to date of leafing and blossoming, season of maturity, and nut characteristics. As a group, however, they tended to be slightly later than mid-season for first terminal leafing. The average size of the nuts from this source was somewhat smaller than present commercial varieties. Their appearance, except for size, was generally good. Kernel color, however, tended to be dark, with 20 percent classified amber, 77 percent light amber, and 3 percent light. Selections from this source, of interest are: P.I. 265717 which combines late leafing with good nut and kernel size; P.I. 145967 bearing nuts of good size and very good quality; P.I. 145974 producing nuts notable for large kernels and early maturity; and P.I. 145979 an early maturing type with nuts of commercial size and good quality.

While seedlings of 12 accessions from this source failed to survive at Morden, Canada, a tree at Salem, Ohio, and three at Cheyenne, Wyoming, are showing some promise of being cold hardy.

USSR SOCHI DISTRICT

As a group the introductions from this area were about mid-season in terminal leafing. Selections of particular interest are P.I. 265715, P.I. 265712, and P.I. 265713 which bore nuts and kernels of large size and P.I. 265714 which is noted for early maturity and high percentage of kernel.



## DISCUSSION

Bennett (2) studying the chilling requirements of pears found that alternating periods of cold and warm temperatures were not as effective in breaking the rest of leaf buds as continued cold without interruption, even though the total cumulative exposure was the same. In an experiment with the peach variety Sullivan Elberta Weinberger (12) likewise found that at certain periods during the dormant season, particularly December at Fort Valley, Georgia, the occurrence of high temperatures would prolong dormancy of this variety. In addition Serr (7) has recognized that some walnut varieties are capable of starting growth in the spring at lower temperatures than others.

Considering these findings of Bennett, Weinberger, and Serr, it appears that two separate factors were responsible for the prolonged leafing and blossoming period of 1948. First, the high temperatures of January apparently offset some of the previous chilling and tended to prolong the rest period. Secondly, the below average growing temperatures of March 48.6°F. as compared with an average of 54.5°F. delayed the early leafing of some individuals and slowed the growth rate for others, which then tended to lengthen the leafing and blossoming season.

Many of the seedlings which had leafed out early in 1948 apparently had their rest period broken by February 1, 1949, with an accumulation of 1480 hours below 45°F. The early-leafing seedlings were held back, however, by the low temperatures and cloudy wet weather which persisted from February 1 to March 21, there being only 11 clear days during this period. Ackerman et al., (1) recorded a similar delay in the blossoming of low chilling peaches and nectarines during this same season (1948-49). The additional accumulation of 501 hours of temperature below 45°F. between February and the end of March was apparently sufficient to break the rest period of the higher chilling types. With the advent of warm weather during the last part of March and early April all seedlings were able to leaf out and bloom during a relatively short period.

While most of these walnut introductions are inferior in one or more respects to commercial varieties grown in California, they are of increasing interest for potential cold hardiness. This is especially true of those from countries having severe winters such as Afghanistan, Bulgaria, Estonia, Manchuria, Poland, and the USSR. Although individual seedling characteristics are variable, a trend towards late leafing and blossoming can be noted in the Polish introductions. Also each of the four accessions from China produce large nuts with plump kernels and good crack out percentages. At least one from this source P.I. 125248 has shown blight resistance (7), and two others P.I. 125249 and P.I. 18256 produce large size and sometimes very good kernel quality when used in crosses (7). These data suggest the desirability of continuing to introduce walnuts from these sources for continued testing and potential use as breeding stock.



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TABLE 1

Source, dates of first terminal leafing, full male and female bloom, dichogamy, yield, harvest season, and nut characteristics of a group of seedling walnut introductions grown at Chico, California

Source	P.I.No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom		Dichogamy <sup>a</sup>	Yield <sup>b</sup>	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>				
				1948	1949	1948	1949														
Afghanistan																					
"	159560	D 42-6	3/17	3/8	3/25	4/5	4/6	4/20	4/9	--	F	E	P	M	33	P	F	51	6	LA	G
"	127460	D 37-25	3/19	3/10	3/27	4/17	4/10	4/17	4/6	Pg	P	VG	P	M	31	F	P	--	-	A	F
"	127458	D 37-9	3/19	3/10	3/28	4/12	4/7	4/23	4/8	--	P	P	P	M	--	-	-	--	-	-	-
"	159567	D 42-14	3/19	3/10	3/28	4/5	4/5	4/23	4/13	Pa	F	G	P	E	33	F	F	45	7	LA	G
"	159559	D 42-3	3/20	3/10	3/30	4/20	4/15	4/17	4/9	Pg	P	VG	P	M	35	F	F	47	6	A	VG
"	127459	D 37-20	3/21	3/15	3/27	4/12	4/4	4/20	4/12	Pa	F	VG	G	E	32	P	F	47	5	LA	G
"	127460	D 42-22	3/21	3/15	3/27	4/12	4/3	4/26	4/12	Pa	P	G	P	L	34	P	F	52	7	A	VG
"	127461	D 37-36	3/22	3/15	3/29	----	---	----	4/15	--	-	P	P	-	33	P	F	50	5	LA	G
"	127459	D 42-9	3/23	3/19	3/27	4/10	4/4	4/20	4/14	Pa	P	P	P	E	31	P	G	--	-	LA	G
"	127459	D 42-7	3/23	3/15	3/30	4/8	4/8	4/20	4/15	Pa	P	P	P	M	34	P	F	46	6	LA	G

Key      <sup>a</sup>Dichogamy Pa- Protandrous - Shedding pollen before female flowers on the same tree are receptive  
                 Pg- Protogynous - Female flowers receptive before pollen is shed

<sup>b</sup>Yield P-Poor F-Fair G-Good VG-Very Good E-Excellent

<sup>c</sup>Harvest season E-Early M-Mid L-Late VL-Very Late

<sup>d</sup>Shape F-Franquette E-Eureka P-Payne

<sup>e</sup>Separation of kernel P-Poor F-Fair G-Good VG-Very Good

<sup>f</sup>Kernel color EL-Extra Light L-Light LA-Light Amber A-Amber

<sup>g</sup>Quality P-Poor F-Fair G-Good VG-Very Good E-Excellent



Table 1 (Cont.)

Source	P. I. No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup> 19 19 19 48 49 58	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>	
				1948	1949	1948	1949	1948	1949											
				1948	1949	Male	Female	1948	1949											
<b>Afghanistan</b>																				
"	127458	D 37-12	3/23	3/19	3/27	4/10	4/6	4/26	4/14	Pa	F	G	P	M	33	F	F	41	5	A G
"	127461	D 37-32	3/24	3/19	3/28	4/17	4/9	4/20	4/8	Pg	F	G	P	M	34	P	P	--	-	G G
"	159563	D 37-14	3/24	3/19	3/29	4/23	4/9	4/20	4/8	Pg	P	G	P	M	33	P	P	51	7	LA G G
"	127459	D 42-2	3/24	3/19	3/29	----	4/10	4/20	4/9	Pg	P	G	P	M	33	P	P	45	6	LA G G
"	159566	D 42-12	3/24	3/19	3/28	4/12	4/5	4/23	4/13	Pa	F	F	P	E	31	F	F	44	4	L L
"	159561	D 42-8	3/24	3/19	3/28	4/12	4/6	4/23	4/16	Pa	F	P	P	E	26	P	P	56	4	LA G G
"	127459	D 37-18	3/24	3/19	3/28	4/12	4/5	4/26	4/15	Pa	F	G	F	M	33	F	F	46	6	LA G G
"	159572	D 42-21	3/24	3/19	3/29	4/12	4/5	4/26	4/17	Pa	P	P	P	E	31	F	G	50	6	LA G G
"	159571	D 42-20	3/24	3/19	3/29	4/10	---	4/23	----	Pa	P	-	P	E	31	F	F	--	-	LA P
"	127460	D 42-13	3/25	3/19	3/30	4/17	4/12	4/17	4/12	--	F	VG	P	E	30	P	F	48	5	L G
"	127459	D 37-19	3/25	3/19	3/30	4/17	----	4/20	4/15	Pg	P	P	P	M	37	P	VG	44	5	LA F
"	127459	D 42-4	3/25	3/19	3/30	4/10	4/8	4/23	4/15	Pa	F	VG	P	M	31	F	F	48	5	LA G
"	159558	D 37-11	3/27	3/26	3/28	4/17	4/8	4/20	4/8	Pg	G	G	F	E	34	F	F	49	8	LA G
"	127460	D 42-19	3/28	3/26	3/30	4/26	4/14	4/20	4/8	Pg	P	G	P	E	36	P	G	45	6	LA G
"	127459	D 42-5	3/28	3/26	3/29	4/23	4/13	4/20	4/13	Pg	G	VG	P	M	33	P	F	38	5	A G
"	127461	D 37-31	3/28	3/26	3/29	4/12	4/7	4/28	4/14	Pa	P	G	P	E	29	F	G	53	5	A F
"	127461	D 37-34	3/29	3/30	3/28	----	----	4/20	4/12	--	P	P	G	M	37	P	-	--	-	G G
"	159581	D 42-42	3/30	3/30	3/29	4/26	4/14	4/22	4/14	Pg	F	G	P	M	31	F	F	--	-	G G
"	163538	D 42-43	3/30	3/30	3/30	5/1	4/16	4/23	4/12	Pg	F	P	P	E	36	P	F	48	6	LA G
"	127459	D 37-17	3/30	3/30	3/29	----	4/6	4/26	4/12	Pa	P	G	G	M	33	P	F	51	6	A G
"	127460	D 42-11	3/30	3/30	3/30	4/26	----	4/23	4/14	Pg	P	P	P	L	32	F	P	41	6	LA F
"	159573	D 37-33	3/30	3/30	3/30	----	----	4/26	4/13	--	F	P	P	E	32	P	G	48	5	LA G
"	127460	D 37-24	3/30	3/30	3/30	4/17	4/8	4/26	4/15	Pa	P	F	P	M	35	P	G	55	7	A P

and the corresponding values for the first three EOFs are 0.50, 0.35, and 0.25, respectively. The correlation coefficients between the first three EOFs and the PC1 are 0.99, 0.95, and 0.92, respectively.

The EOFs of the PC1 are plotted in Fig. 1. The first EOF has a positive correlation with the PC1, while the second and third EOFs have negative correlations with the PC1. The first EOF has a positive correlation with the PC1, while the second and third EOFs have negative correlations with the PC1.

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Table 1 (Cont.)

Source	P. I. No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup> 19 19 19 48 49 58	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>		
				1948	1949	Male	Female	1948	1949												
				1948	1949	1948	1949	1948	1949												
<b>Afghanistan</b>																					
"	159568	D 42-15	3/30	3/30	3/29	4/12	4/4	4/26	4/16	Pa	F	VG	P	E	33	F	G	53	7	LA	F
"	159569	D 42-16	3/31	3/30	4/1	5/4	4/15	4/20	4/13	Pg	P	F	P	E	33	F	F	54	7	LA	GG
"	127460	D 37-29	3/31	3/30	4/1	4/12	4/8	4/26	4/13	Pa	P	G	P	E	28	F	F	41	4	LA	G
"	127460	D 42-17	3/31	3/30	3/31	4/23	4/13	4/23	4/12	Pg	P	F	P	E	34	P	F	47	6	LA	F
"	116932	D 37-38	4/1	3/30	4/2	4/12	----	4/26	4/7	Pa	-	P	P	-	--	-	-	--	--	--	-
"	127460	D 37-28	4/3	4/7	3/30	4/26	4/13	4/26	4/11	Pg	P	F	P	E	32	P	F	46	6	LA	GG
"	159557	D 37-10	4/3	4/7	3/30	4/26	4/14	4/26	4/18	Pg	G	G	P	E	36	P	F	--	-	LA	VG
"	159562	D 37-13	4/4	4/7	4/1	4/26	4/8	4/25	4/15	--	G	E	VG	M	33	P	G	47	5	L	G
"	265720	D 42-45	4/4	4/7	4/1	----	4/10	4/26	4/18	Pg	P	F	P	M	34	F	VG	42	6	LA	G
"	163539	D 42-44	4/5	4/10	3/31	----	4/10	5/4	4/17	Pa	P	F	P	E	36	F	F	47	7	L	G
"	127460	D 37-30	4/6	4/10	4/2	4/20	4/8	5/5	4/18	Pa	F	G	P	M	35	F	P	40	6	LA	G
"	127460	D 37-26	4/7	4/12	4/2	4/26	4/10	5/6	4/16	Pa	P	P	P	M	32	P	G	54	6	LA	F
<b>Algeria</b>																					
"	61855	D 35-9	3/25	3/19	3/30	4/17	4/7	5/1	4/14	Pa	F	G	F	E	34	F	-	48	6	A	G
<b>Bulgaria</b>																					
"	107627	D 35-12	3/30	3/30	3/30	5/1	4/17	4/23	4/13	Pg	F	P	P	M	28	F	G	50	4	A	F
"	107627	D 35-11	3/31	3/30	4/1	4/23	4/12	5/1	4/12	--	P	-	F	E	32	F	F	43	4	A	F
<b>Chile</b>																					
"	265716	D 35-7	3/24	3/19	3/29	4/10	4/7	4/23	4/14	Pa	F	VG	P	E	30	F	F	52	6	LA	G



Table 1 (Cont.)

Source	P. I. No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup> 19 19 19 48 49 58	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>		
				1948	1949	Male	1948	1949	1948												
				1948	1949		1948	1949													
China																					
"	125248	D 18-5	3/22	3/15	3/28	4/7	4/7	4/26	4/11	--	VG	VG	G	E	38	F	G	49	7	L	G
"	125249	D 18-6	3/24	3/19	3/29	4/17	4/11	4/17	4/10	Pg	VG	G	F	E	36	P	G	54	8	LA	G
"	125239	D 36-34	3/26	---	4/28	----	4/20	----	Pg	E	-	G	M	40	P	G	48	7	A	G	
Estonia																					
"	159578	D 42-33	3/30	3/30	3/30	4/17	4/7	4/26	4/15	Pa	G	G	P	L	27	P	F	45	4	LA	G
"	265719	D 42-30	4/3	4/7	3/29	4/17	4/8	5/6	4/15	Pa	G	F	P	L	27	F	VG	55	4	L	F
"	131353	D 42-31	4/4	4/7	3/31	4/17	4/9	5/6	4/18	Pa	G	F	P	L	30	F	F	52	6	LA	G
"	131353	D 42-35	4/6	4/10	4/1	4/22	4/11	4/28	4/15	Pa	G	F	P	L	27	F	F	49	4	LA	G
"	131353	D 42-34	4/7	4/12	4/2	5/1	4/17	4/26	4/11	Pg	P	F	P	M	34	F	F	43	6	A	G
"	131353	D 42-32	4/12	4/17	4/6	5/4	----	4/26	4/18	Pg	F	P	P	M	--	-	F	--	-	LA	G
India																					
"	54788	D 35-42	3/17	3/10	3/23	3/30	4/2	----	4/18	Pa	-	P	P	-	35	F	P	--	-	LA	P
"	125246	D 36-41	3/19	3/19	----	4/23	----	4/17	----	Pg	VG	-	P	M	32	F	G	51	7	LA	F
"	63430	D 36-42	3/24	3/24	----	4/11	----	4/17	----	Pa	P	-	P	M	30	F	F	51	6	LA	G
"	63430	D 36-43	3/26	3/26	----	----	----	----	----	--	P	-	P	M	32	F	F	43	7	A	G
"	265718	D 35-43	4/8	4/10	4/5	----	----	5/2	4/12	--	F	P	-	Irregular	P	--	-	-	-	LA	F
Iran																					
"	125247	D 38-5	3/22	3/19	3/25	4/12	4/6	4/26	4/13	Pa	G	F	P	L	33	F	F	52	7	LA	G
"	125247	D 38-6	3/23	3/19	3/27	4/10	4/5	4/26	4/13	Pa	VG	G	P	L	31	F	F	--	-	LA	F
"	125243	D 38-3	3/23	3/19	3/27	4/17	4/9	4/17	4/10	Pg	G	G	P	M	38	P	VG	53	9	L	G

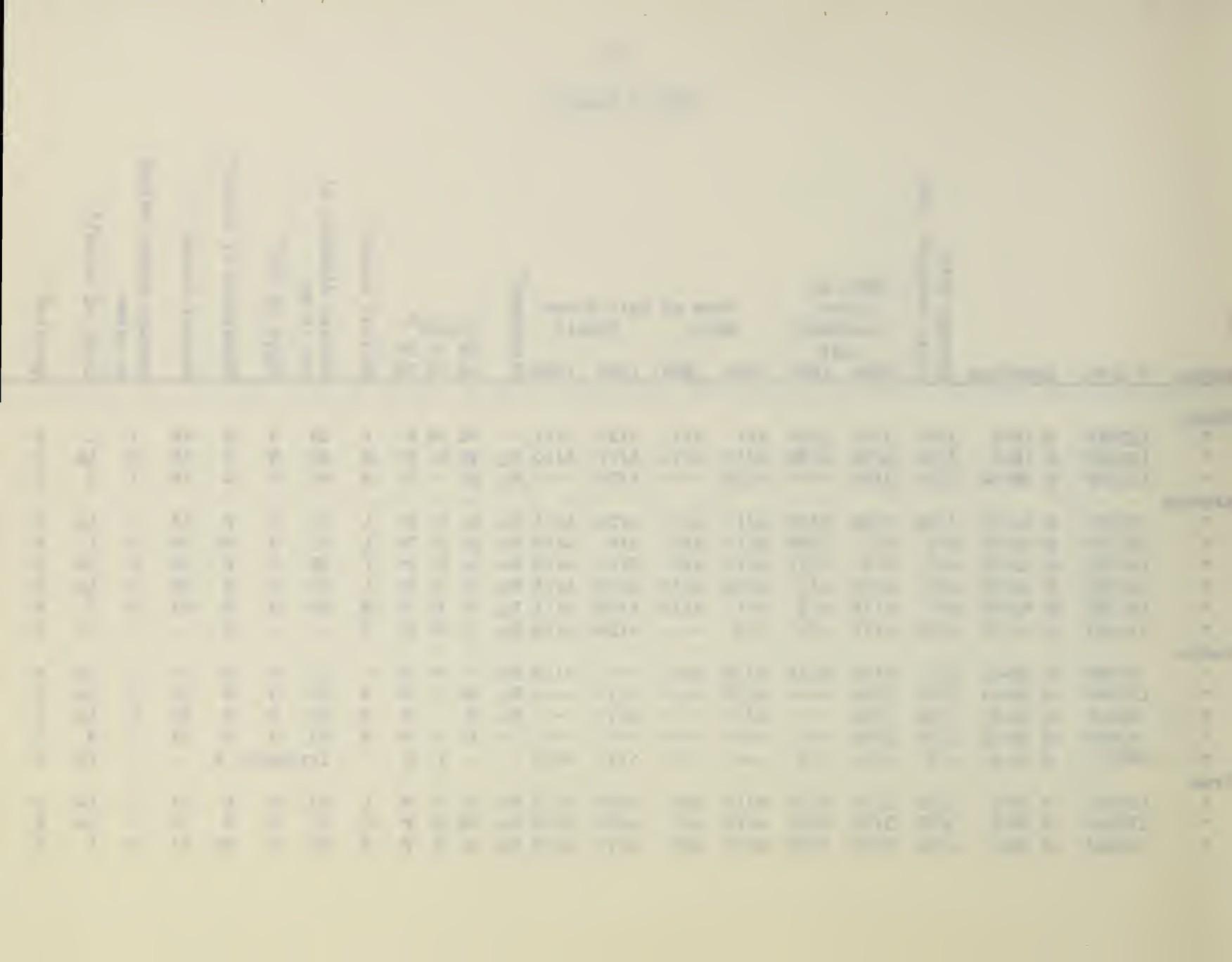


Table 1 (Cont.)

Source	P. I. No.	Location	Average date first terminal leaf	Date of first terminal leaf												Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup> 1948 1949 1948 1949 48 49 58	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>
				1948	1949	Male	Female	1948	1949	1948	1949	F	P	G	VG	51	5	LA	G										
<b>Iran</b>																													
"	125243	D 38-4	3/24	3/19	3/28	4/17	4/10	4/17	4/10	Pg	F	F	P	M	35	P	G	51	5	LA	G								
"	125245	D 18-10	3/30	3/30	3/29	4/17	4/9	4/26	4/15	Pa	P	VG	P	L	30	F	VG	50	5	LA	G								
<b>Manchuria</b>																													
"	125240	D 18-3	3/24	3/19	3/28	4/7	4/6	4/20	4/11	Pa	VG	E	P	M	35	P	G	45	7	LA	G								
<b>Poland</b>																													
"	159555	D 37-1	3/28	3/26	3/30	4/12	4/8	4/26	4/17	Pa	G	E	P	L	28	F	F	34	3	A	F								
"	142325	D 36-29	3/29	3/26	3/ 1	4/23	4/14	4/23	4/17	Pg	F	P	F	L	32	F	P	45	5	LA	F								
"	125194	D 35-4	3/31	3/30	3/31	4/23	4/12	4/23	4/12	Pg	P	P	P	M	30	F	VG	47	4	LA	G								
"	142331	D 38-9	3/31	3/30	3/31	----	4/14	4/23	4/13	Pg	G	F	P	L	40	square	F	29	6	LA	G								
"	142330	D 37-4	3/31	3/30	4/1	4/23	4/17	4/26	4/12	Pg	F	P	P	M	28	P	P	--	-	LA	G								
"	159543	D 35-3 N. limb		3/31	3/30	3/31	4/20	4/10	4/23	4/17	Pg	P	P	P	E	--	-	-	--	-	-	G							
"	159548	D 36-15	4/2	3/30	4/4	4/28	4/20	4/23	4/14	Pg	F	P	P	E	30	F	F	50	5	LA	G								
"	159549	D 36-18	4/3	4/5	4/1	4/28	4/17	4/23	4/11	Pg	VG	P	G	L	31	P	F	42	4	A	G								
"	125193	D 36-9	4/4	4/7	4/1	4/28	4/15	4/23	4/11	Pg	P	P	P	L	--	-	G	--	-	LA	F								
"	159556	D 42-39	4/5	4/7	4/2	----	4/15	4/26	4/15	--	G	G	P	L	30	F	F	34	4	LA	G								
"	159554	D 36-32	4/5	4/5	----	4/23	----	4/23	----	Pg	P	-	F	L	29	F	F	43	4	LA	G								
"	142321	D 36-25	4/5	4/11	3/29	4/23	4/7	5/6	4/14	Pa	F	P	F	L	29	F	F	41	5	LA	G								
"	159550	D 36-19	4/5	4/5	4/4	----	4/9	5/6	4/16	--	P	P	F	E	27	F	P	--	-	LA	G								
"	142323	D 36-27	4/6	4/10	4/1	5/4	4/18	5/3	4/11	Pg	P	F	F	M	31	F	F	52	6	LA	G								
"	125194	D 36-10	4/6	4/10	4/1	4/23	4/9	5/3	4/16	Pa	F	G	P	L	27	P	P	--	-	LA	G								



Table 1 (Cont.)

Source	P.I.No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup> 1948 1949 1949	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>	
				1948	1949	Male	Female	1948	1949											
Poland																				
"	125194	D 36-13	4/6	4/11	4/1	4/23	4/9	5/4	4/14	Pa	P	P	P	M	30	F	F	38	3	LA G
"	142320	D 36-24	4/6	4/11	4/1	4/20	4/10	5/6	4/17	Pa	F	F	F	M	28	F	F	48	5	LA GG
"	159545	D 36-11	4/6	4/10	4/1	4/23	4/9	5/5	4/17	Pa	G	G	P	M	28	F	P	--	-	LA
"	142328	D 37-2	4/6	4/10	4/2	4/22	4/8	5/6	4/18	Pa	F	VG	F	L	32	F	G	43	5	LA
"	142322	D 36-26	4/7	4/12	4/1	5/6	4/18	4/23	4/15	Pg	P	P	P	M	34	P	F	49	6	A
"	142329	D 37-3	4/7	4/7	4/6	4/22	4/12	5/6	4/19	Pa	F	F	F	L	25	P	P	--	-	LA
"	159552	D 36-22	4/8	4/11	4/4	5/5	4/17	4/23	4/14	Pg	G	F	G	L	29	F	F	49	5	LA G
"	142324	D 36-28	4/8	4/11	4/4	4/23	4/10	5/5	4/16	Pa	G	F	G	L	--	-	F	--	-	A P
"	125194	D 36-17	4/10	4/19	3/31	----	4/8	5/6	4/17	Pa	G	F	F	VL	28	P	F	36	3	LA G
"	142327	D 36-31	4/10	4/10	----	5/3	----	5/8	----	Pg	P	-	-	L	35	F	VG	43	6	L G
"	159551	D 35-20	4/11	4/17	4/4	4/28	4/12	----	4/18	Pa	F	P	F	M	31	F	P	50	6	LA G
"	142326	D 36-30	4/11	4/17	4/3	5/6	4/18	5/6	4/14	Pg	P	P	P	M	33	P	F	--	-	G
"	125194	D 36-16	4/11	4/17	4/4	5/6	4/17	5/6	4/16	Pg	P	P	P	M	31	F	VP	--	-	LA G
"	159553	D 35-23	4/11	4/17	4/5	4/23	4/11	5/6	4/17	Pa	F	G	G	L	30	P	F	33	4	LA G
"	159546	D 36-12	4/12	4/17	4/6	4/23	4/14	5/6	4/16	Pa	F	F	F	M	31	F	P	29	4	LA G
"	159547	D 36-14	4/12	4/17	4/6	5/5	----	5/5	4/17	Pg	P	P	P	M	36	F	G	--	-	G
"	159544	D 36-7	4/13	4/19	4/6	----	4/15	5/6	4/19	Pa	F	G	G	E	27	F	F	45	4	LA G
"	228149	D 36-21	4/14	4/19	4/8	5/5	----	5/6	4/18	Pg	P	P	P	E	30	F	G	47	5	LA F
Carpathian Mountains																				
"	110036	D 35-34	3/19	3/10	3/27	4/17	4/11	4/17	4/7	--	F	G	P	E	33	F	P	42	5	A F
"	145973	D 35-25	3/23	3/19	3/27	4/7	4/6	4/23	4/9	Pa	F	VG	P	M	31	P	G	54	6	LA G



Table 1 (Cont.)

Source	P.I. No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup> 1948 1949 1948 1949	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>		
				1948	1949	Male	Female	1948	1949												
<b>Carpathian Mountains</b>																					
"	145971	D 35-22	3/25	3/19	3/30	4/19	4/10	4/23	4/16	Pa	G	G	F	M	32	F	F	50	5	LA	F
"	145976	D 35-31	3/27	3/26	3/28	4/26	4/12	4/23	4/8	Pg	F	P	P	L	32	P	P	54	7	LA	FG
"	145968	D 35-15	3/27	3/26	3/28	4/17	----	5/6	4/15	Pa	G	G	P	M	33	F	F	46	7	LA	F
"	110049	D 36-3	3/28	3/26	3/29	4/7	4/6	4/23	4/11	Pa	F	P	P	M	32	F	F	40	5	LA	F
"	145974	D 35-26	3/28	3/26	3/30	5/1	4/14	4/20	4/13	Pg	F	P	P	E	31	E	E	49	7	LA	F
"	159542	D 35-35	3/30	3/30	3/29	----	4/14	4/20	4/15	Pg	F	F	F	L	31	F	F	34	5	LA	G
"	110044	D 35-39	3/30	3/30	3/30	4/23	4/15	4/23	4/15	Pg	-	-	G	-	31	F	F	41	4	LA	P
"	145972	D 35-24	3/30	3/30	3/29	4/19	4/7	5/1	4/15	Pa	F	G	P	M	31	F	F	36	4	LA	G
"	110026	D 35-20	3/30	3/30	3/30	4/19	----	5/3	4/16	Pa	F	F	P	M	30	F	F	43	5	LA	G
"	110048	D 36-1	3/31	3/30	4/1	4/20	4/15	4/20	4/14	--	F	P	P	L	34	F	F	44	6	LA	G
"	145979	D 36-4	3/31	3/30	4/1	4/20	4/12	4/23	4/10	Pg	F	P	P	E	33	E	E	48	6	LA	G
"	110037	D 35-36	3/31	3/30	4/1	----	4/16	4/23	4/12	--	P	P	F	E	31	F	F	54	5	LA	F
"	145967	D 35-13	3/31	3/30	3/31	4/23	4/13	4/23	4/13	Pg	G	P	F	L	32	F	F	44	6	LA	VG
"	110028	D 35-23	3/31	3/30	3/31	4/19	----	4/23	4/14	Pa	VG	VG	F	M	28	F	F	--	-	LA	G
"	145978	D 36-2	3/31	3/30	4/1	4/19	4/9	5/1	4/15	Pa	F	C	P	E	34	F	F	55	5	LA	G
"	110032	D 35-30	4/2	4/5	3/29	4/28	4/12	4/23	4/13	Pg	F	F	P	M	31	F	F	45	6	A	G
"	110031	D 35-29	4/3	4/5	3/31	4/26	4/17	4/26	4/13	Pg	F	-	P	L	29	F	F	39	4	A	P
"	110045	D 35-40	4/3	4/5	3/31	4/15	4/10	5/4	4/17	Pa	F	P	G	L	30	F	F	36	5	A	F
"	110033	D 35-33	4/4	4/7	4/1	----	4/11	5/6	4/18	Pa	F	F	P	E	27	F	F	41	3	A	F
"	145970	D 35-19	4/6	4/10	4/1	5/3	4/17	4/23	4/13	Pg	G	VG	P	E	32	F	F	45	5	LA	G
"	110051	D 36-5	4/6	4/7	4/4	4/20	4/9	5/4	4/16	Pa	G	VG	G	M	29	F	F	40	3	LA	F
"	110022	D 35-14	4/6	4/10	4/1	4/17	----	5/6	4/18	Pa	.F	G	P	L	26	F	F	42	4	LA	G
"	145977	D 35-32	4/6	4/10	4/1	5/1	4/12	5/6	4/18	--	F	VG	F	M	31	F	F	45	5	LA	G
"	265717	D 35-38	4/6	4/7	4/4	--	----	5/6	----	Pa	P	F	F	M	32	F	G	50	6	LA	G
"	110024	D 35-17	4/8	4/10	4/6	4/23	----	5/6	----	Pa	F	VG	P	M	27	P	P	32	3	LA	F



Table 1 (Cont.)

Source	P. I. No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup>			Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams <sup>f</sup>	Color of kernel <sup>f</sup>	Quality <sup>g</sup>
				1948	1949	Male	Female	1948	1949		48	49	58								
<b>Carpathian Mountains</b>																					
"	110027	D 35-21	4/8	4/10	4/6	4/23	4/12	5/6	4/18	Pa	G	VG	F	L	28	F	G	52	5	LA	G
"	145969	D 35-16	4/8	4/10	4/5	4/23	---	5/6	4/18	Pa	G	VG	P	E	28	F	G	44	4	L	G
"	159541	D 35-18	4/8	4/10	4/5	5/1	4/18	4/23	4/15	Pg	G	G	P	E	30	P	G	35	4	A	F
<b>USSR</b>																					
"	128825	D 42-41	3/30	3/30	3/30	4/17	4/9	4/26	4/17	--	G	VG	P	M	30	E	G	50	5	LA	F
"	98238	D 18-1	4/12	4/20	4/4	----	----	----	----	--	P	P	P	VL	33	P	F	48	5	LA	F
<b>USSR Sochi Dist.</b>																					
"	102089	D 18-21	3/23	3/19	3/27	4/10	4/8	4/26	4/12	Pa	P	G	P	L	30	P	F	45	3	A	G
"	102091	D 18-22	3/23	3/19	3/27	4/23	4/10	4/26	4/13	Pg	F	P	P	L	28	F	P	38	4	LA	G
"	265714	D 18-24	3/24	3/19	3/29	4/10	4/8	4/20	4/13	Pa	P	F	P	E	31	F	F	55	5	LA	G
"	102091	D 19-10	3/26	3/26	----	4/10	----	4/26	----	Pa	-	-	P	-	30	F	G	46	5	A	G
"	265712	D 18-20	3/27	3/26	3/28	4/26	4/11	4/20	4/12	Pg	P	P	P	M	34	F	F	50	6	LA	G
"	145984	D 18-17	3/28	3/26	3/29	4/15	4/6	4/26	4/12	Pa	P	-	P	M	31	P	F	47	5	LA	F
"	265713	D 18-23	3/29	3/26	4/1	4/17	4/9	4/26	4/16	Pa	P	P	P	M	32	F	F	49	6	LA	G
"	102096	D 19-17	3/30	3/30	----	----	----	4/26	----	Pa	P	-	P	M	29	P	F	52	5	LA	F
"	102095	D 18-25	4/3	4/5	3/31	----	4/9	4/26	4/15	--	F	F	P	M	30	P	P	42	4	LA	G
"	102094	D 19-14	4/5	4/5	----	----	----	4/26	----	F	-	F	L	31	F	P	54	6	LA	F	
"	102092	D 19-11	4/7	4/7	----	5/3	----	4/26	----	G	-	P	L	33	P	P	--	5	LA	G	
"	102087	D 19-9	4/10	4/10	----	4/26	----	5/6	----	Pa	F	-	P	L	30	P	F	51	5	A	G
"	265715	D 19-8	4/10	4/10	----	4/22	----	4/20	----	F	-	P	L	35	P	VG	52	6	LA	F	
"	102092	D 19-12	4/17	4/17	----	4/26	----	5/6	----	Pa	P	-	P	VL	27	F	F	39	3	LA	F
<b>USSR Caucasus region</b>																					
"	100276	D 18-15	4/3	4/5	4/1	4/15	4/11	5/6	4/16	Pa	P	F	P	M	31	F	G	50	5	LA	F

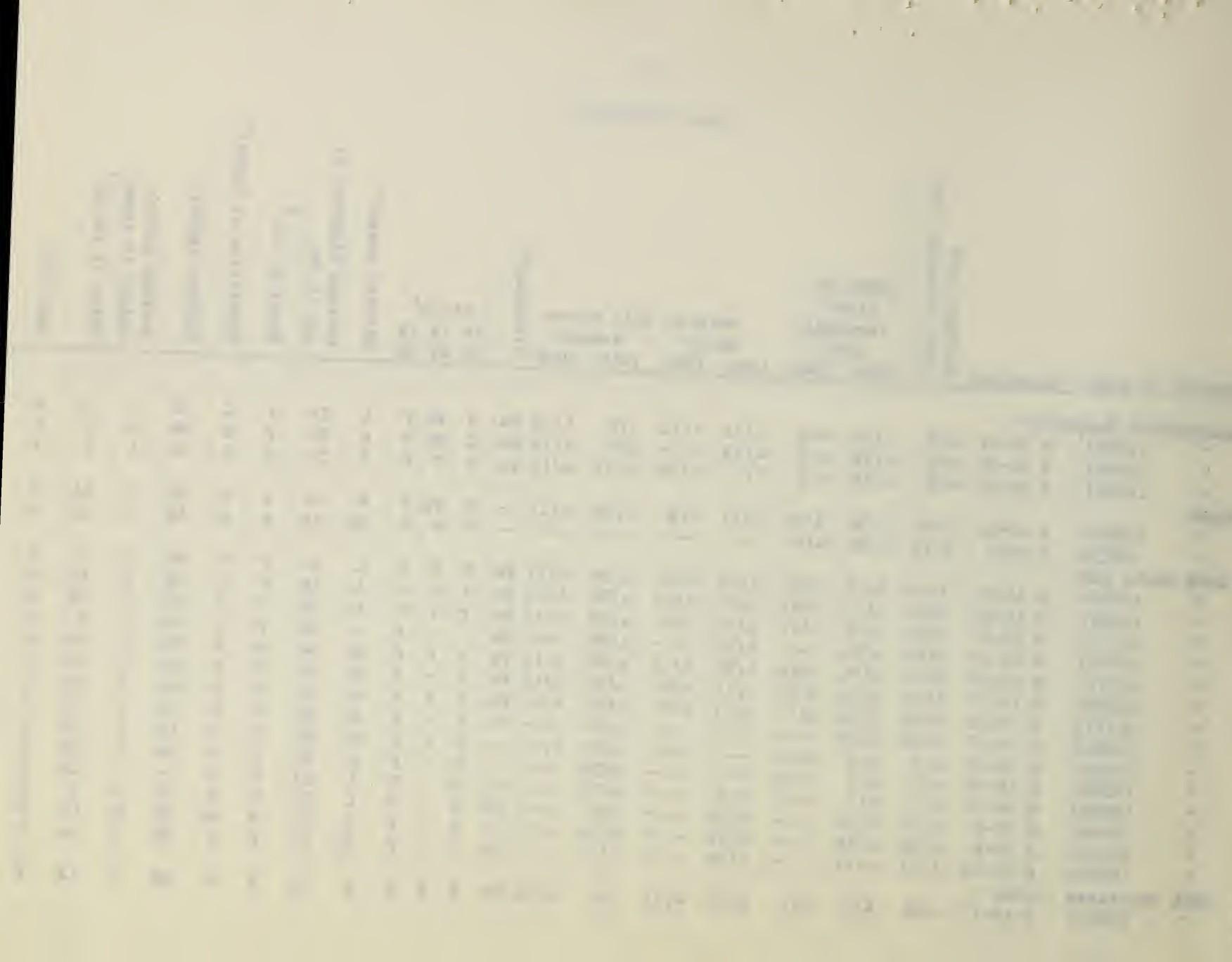


Table 1 (Cont.)

Source	P. I. No.	Location	Average date first terminal leaf	Date of first terminal leaf		Date of full bloom				Dichogamy <sup>a</sup>	Yield <sup>b</sup> 19 19 19 48 49 58	Harvest season <sup>c</sup>	Average diameter of nut in mm	Shape of nut <sup>d</sup>	Separation of kernel <sup>e</sup>	Percent kernel	Average kernel weight in grams	Color of kernel <sup>f</sup>	Quality <sup>g</sup>
				1948	1949	Male	Female	1948	1949										
				1948	1949	1948	1949	1948	1949										
<b>STANDARDS</b>																			
<b>Wheeler Franquette</b>											P F F L								
" C19447	D 38-2	4/20	4/26	4/14	----	----	----	----	----	P F F L	31	F	G	45	5	LA	G		
" C19447	D 38-1	4/21	4/26	4/15	----	----	----	----	----	P F - L	31	F	F	43	4	LA	G		
" C19447	D 35-45	4/22	4/30	4/14	----	4/18	----	----	----	VG VG F L	33	F	G	51	5	L	G		
<b>Manregian<sup>1</sup></b>																			
" 18256	D 35-1	3/27	3/26	3/28	4/10	4/7	4/23	4/11	Pa	P P P M	42	F	G	53	9	LA	G		
<b>Sorrentina<sup>2</sup></b>																			
" 33189	D 42-1	3/31	3/30	3/31	4/23	4/8	4/28	4/17	Pa	P VG - M	29	E	F	37	4	L	G		
<b>Hartley<sup>3</sup></b>																			
" -----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	35	-	G	47	6	L	G		
<b>Franquette<sup>3</sup></b>																			
" -----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	31	-	G	46	5	LA	G		
<b>Eureka<sup>3</sup></b>	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	33	-	G	48	8	LA	G		
<b>Payne<sup>3</sup></b>	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	33	-	VG	48	5	LA	G		

<sup>1</sup>on Juglans honorii rootstock

<sup>2</sup>on Pterocarya stenoptera rootstock - see reference (5)

<sup>3</sup>1958 crop from local sources

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Table 2

Relationship between source and number of seedlings  
showing first terminal leafing by date for 1948 and 1949



Table 2 (Cont.)

Relationship between source and number of seedlings  
showing first terminal leafing by date for 1948 and 1949

1970

1970  
1970

1970  
1970

Table 3

Weather data in monthly periods  
between September 1st and April 30th  
during the years 1947-48 and 1948-49

Month	Average Temperature Degrees Fahrenheit with departure from normal				Total Precipitation (inches) and departures from normal				Accumulative Summa- tions of hours of temp. below 45° F	
	1947-48		1948-49		1947-48		1948-49		1947-48	1948-49
	Temp.	Departure	Temp.	Departure	Precip.	Departure	Precip.	Departure		
Sept.	74.9	2.1	70.3	-2.5	T	-0.50	.22	-0.28	2	12
Oct.	62.2	-1.7	62.7	-1.2	5.38	4.11	.33	-0.94	10	61
Nov.	49.4	-3.8	51.6	-1.6	1.98	-0.71	1.33	-1.36	312	316
Dec.	43.9	-2.6	42.5	-4.0	2.05	-2.48	4.73	.20	798	838
Jan.	48.8	2.9	37.5	-8.4	2.51	-2.35	.91	-3.95	1107	1480
Feb.	46.8	-2.3	45.6	-3.5	1.56	-2.69	1.84	-2.41	1444	1814
Mar.	48.6	-5.9	51.6	-2.9	5.18	2.03	8.38	5.23	1710	1981
April	52.9	-7.1	62.5	2.5	5.37	1.97	T	-1.76	1829	2021

